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MECHANICAL POWER[1]

I HAVE selected for my address to-night the subject of power—mechanical power—because I believe even workers in science do not fully appreciate the extent to which our present-day civilization is dependent upon this product of science. It is only within a century, however, that mechanical power has become so great a factor in our daily lives.

A century is a very short period in comparison with the number of years man has inhabited this earth. Up to within about a century ago, man truly obeyed the biblical injunction to earn his bread by the sweat of his brow, for the great majority of men and women were slaves or serfs. The Greek and Roman civilizations rested on slavery. Athens had 400,000 slaves to 100,000 free citizens. The industries of Rome were run almost entirely by slave labor.

In the latter days of the Roman Empire, water power became sufficiently developed to compete with slave labor, and "water mills" gradually displaced slave labor in the bakeries, in irrigation and in sawing marble. During the middle ages, mechanical power from water wheels and wind mills was applied in grinding grain, in metallurgical processes and in mining and quarrying, but to a limited extent only.

By the end of the seventeenth century, the coal-mining industry reached appreciable proportions in England and on the continent. As the mines were worked to greater depths, the pumping of water from them became a serious problem. The pumps were operated by horses—as many as 500 horses being employed at one mine for this purpose. The expense of pumping became so great that many mines were abandoned. This situation was relieved by the invention of the steam-pumping engine—that of Savery in 1698 and of Newcomen in 1705.

Economic conditions at this time—the first half of the eighteenth century—are indicated by the average wages of a skilled workman in England, about $2.40 a week. Wheat varied from $1.00 to $1.50 a bushel. Thus, the carpenter or mason could earn only from two to three bushels of wheat for his week's work.

Before the eighteenth century, man used only a few elements of machines and crude combinations of them. In the latter part of that century occurred those great inventions in spinning and in weaving where the skill and intelligence of the workman were transferred to

[1] Address of the retiring president of the Nebraska Chapter of Sigma Xi on May 15.

machinery operated by mechanical power. The nineteenth century witnessed the development of machinery with greater than human skill and with but little less than human intelligence, many times multiplying man's productiveness through the utilization of mechanical power.

Mill machinery was first operated by water power while the steam engine was first developed to pump water from coal mines. It is therefore not surprising that the first proposal to operate a mill by steam power comprised a steam boiler and engine to convert the heat energy of coal into mechanical energy, a pump to convert the mechanical energy into potential energy of water and a water wheel to convert the potential energy of the water back into the mechanical energy for driving the machinery. The crank connecting rod mechanism was soon invented, however, affording a means of converting reciprocating into rotary motion and thus utilizing more directly the mechanical power of the reciprocating steam engine.

In recent years, we have gone back in many instances to the original proposal, using, however, in place of the water pump, piping and water wheel, an electric generator, transmission line and electric motor between the source of mechanical power and the machinery where the mechanical power is to be utilized. I mention this simply to emphasize the fact that while electricity is often a very convenient means of transmitting power, it is not a primary source of power and it must in general be converted into mechanical power or into heat before it can be utilized.

In 1869, the first year that power statistics were collected by the Bureau of the Census, the mechanical power for the industries of the United States was obtained only from water wheels and from steam engines and boilers fired with coal. The internal combustion engine had not yet reached a practical form. The installed primary power in the manufacturing industries was 1,130,431 horsepower in water wheels and 1,215,711 horsepower in steam engines. In mining and quarrying, the installed primary power was 2,247 horsepower in water wheels and 109,111 horsepower in steam engines. Steam power was used exclusively on the railroads and on ships, amounting to about 3,300,000 and 1,070,000 horsepower, respectively.

In 1869, there was thus available in the United States about 6,827,000 horsepower, of which about 16 per cent. was water power and the remainder steam power. The population was about 38,116,000 people, somewhat less than 0.2 of a horsepower being therefore available for each person.

In the fifty years from 1869 to 1919, remarkable increases occurred in the horsepower available in prime movers. There have been further advances since that date, but the following approximate figures, based partly on the census data for 1919, will give some idea of the tremendous amount of mechanical power now at the service of mankind. In manufacturing, the 2.3 million horsepower of 1869 has grown to more than 29.5 million. In mining and quarrying, the 111 thousand horsepower has increased to over 6.8 million. On the railroads, the horsepower has increased from 3.3 million to sixty-five million or more. The estimated horsepower of the United States Navy is about ten million, and commercial shipping and private yachts and motor boats will account for another ten million horsepower. On the farms, animal power only was used in 1869, amounting to less than ten million horsepower; in 1919, while the animal power had more than doubled, mechanical power to the extent of about 20 million horsepower was employed. Probably four million horsepower are installed in isolated plants in non-industrial establishments. In 1869, central power stations did not exist for furnishing electricity for lighting, railways, etc.; in 1919 they had an installed capacity of twenty million horsepower, of which about ten million, used in industrial plants and on farms, is included in preceding figures. Conservatively, 345 million horsepower in internal combustion engines are installed in the seventeen million automobiles, motor trucks and tractors in use in this country, of which about six million horsepower is already accounted for as employed in agriculture.

The grand total of these figures is over five hundred million horsepower available for a population of 105 million people, or about five horsepower for each man, woman and child. Since a man's power is less than one tenth of a horsepower, this is equivalent to more than fifty slaves for each inhabitant of the United States.

The ancient Greek triremes had ten marines, twenty sailors and 170 rowers. Compare this with the airplane carrier Saratoga, launched a few days ago, having a crew of 179 officers and 1,695 men and propelling machinery of 180,000 horsepower. This power is equivalent to that of two million galley slaves.

Of the five hundred million horsepower available in 1919, about eight million, or less than 2 per cent., was water power. The remainder had for its primary source of energy, coal, petroleum or natural gas, except about one tenth of one per cent. in windmills on farms. The United States Geological Survey has estimated that the amounts of energy contributed by the four main sources of energy in the United States

in 1919 were in the following proportions: Coal, 77.3 per cent.; petroleum, 13.6 per cent.; natural gas, 4.3 per cent.; water power, 4.8 per cent.

The first three sources are limited and will some day be exhausted. It is often assumed that water power will then be developed to take their places. The potential water power resources of the United States, even with water storage, are estimated by the United States Geological Survey to be only 34,818,000 horsepower, or less than one fourteenth of our present installed capacity. Evidently, water power can never take over the burden now borne by coal, oil and gas. Unless science and engineering develop wider applications of what are now minor sources of mechanical power, the human race must some day return to work.

There is a tendency for the man on the street to shrug his shoulders and say that the scientists will discover other sources of energy before that time—that the energy of the atom will be unlocked, that electricity will be taken from the air. To a person not well grounded in the physics of energy and matter, such propositions do not appear any more wonderful than, for example, the radio. But the fact that Mr. E. W. Rice, Jr., of the General Electric Company, estimates a revenue of several million dollars annually for the sale of electric power to operate radio equipment, is an indication that the laws of thermodynamics are not contravened by this device. Although I am inclined to question whether the second law of thermodynamics is of as broad application as generally stated, I regard as very improbable the unlocking of stores of energy from sources other than those already used to some extent.

Some research should be devoted to the development of what are now minor sources of mechanical power. However, the exhaustion of our natural resources of coal, oil and gas is not immediate. Petroleum in quantity will probably be available for two or three hundred years and coal for two or three thousand years. Greater efforts should be exerted to improve the combustion of fuels, the production of mechanical power from the heat of combustion and the utilization of mechanical power by machinery of various kinds.

Although coal will be available for many years, the better grades for metallurgical and power purposes are approaching exhaustion. Methods of utilizing the poorer grades must be developed to higher degrees of efficiency. One method of accomplishing this is through reducing the amount of inert nitrogen in the air supplied for combustion. There is thus needed an economical process for producing oxygen which may be mixed with atmospheric air or used in a nearly pure state.

After combustion has taken place, the energy exists as heat, and improved means should be sought for converting heat energy into mechanical energy. It has been customary to analyze power plant performance by the first law of thermodynamics, but such an analysis should preferably be based upon the second law in order to show where the greatest inefficiencies exist in the process of converting heat into mechanical work. The first law analysis heretofore made is misleading in this respect. For example, according to the first law, no loss whatever results in a steam power plant by heat transfer from the products of combustion in the furnace to the water in the boiler to evaporate it into steam. The second law analysis shows this to be the largest single item of loss in the whole power plant. The subject of heat transfer is thus an important matter of research for improving the production of mechanical power from heat.

Research in utilizing mechanical power is required in order to minimize the expenditure of fuel for the accomplishment of a desired result. While there are a multiplicity of ways of using power, the main item of such research should be friction, for nearly all the energy of mechanical power is finally dissipated as heat in overcoming frictional resistances. This may appear to be a startling statement; yet if you will think of the movement of a railroad train from Lincoln to Chicago through the burning of say thirty tons of coal under the locomotive boiler, you will appreciate that the tractive effort of the locomotive is expended entirely in overcoming the frictional resistances encountered by the train against the air and rails and in the bearings. In industrial processes in general, a negligible amount of mechanical power is stored up in some form of available energy; nearly all of it is dissipated in overcoming friction. Research upon the frictional resistance of fluids flowing through pipes, of bodies moving through fluids and of the lubrication of bearings is thus of the greatest importance in prolonging the life of our fuel resources.

Economic conditions are bringing about improvements in the production and utilization of mechanical power. For example, the coal consumption per kilowatt hour produced by electric utilities dropped 25 per cent. in the five years from 1918 to 1923. Also, steam locomotives have been developed which, in comparison with the standard locomotives of but three years ago, will haul 50 per cent. more tonnage for the same amount of coal burned. Until to-day, coal economy has been of very minor importance in railroad operation; but conditions are changing, and scientific analysis is now being applied to the steam locomotive with very large improvements in efficiency.

Many other instances could be cited of remarkable developments in industrial processes, if the time permitted.

In the early ages of civilization, slavery was probably essential to progress because only through the enforced labor of the many could the few find time to think. The first use of mechanical power freed the slaves of the Roman Empire from their most arduous labor; but its service to mankind was very slight up to the beginning of the eighteenth century, when a skilled workman could earn in a week only the equivalent of two to three bushels of wheat. Mechanical power then relieved animal power in pumping water from mines and brought coal in large quantities to the service of mankind.

The great inventions in spinning and weaving in the latter part of the eighteenth century, and the application to other purposes of the same fundamental principle, namely, that of transferring the workman's skill and intelligence to machinery, multiplied the uses of mechanical power; but the development was comparatively slow up to about 1870. Just before this date, many of the state universities and endowed technical schools had been founded. The supply of scientifically trained men graduated therefrom resulted in an accelerated development of the production of mechanical power and its utilization by machinery for almost every purpose, thereby causing such widely diffused material prosperity that the skilled worker's weekly wages are now equivalent to twenty to thirty bushels of wheat.

In the fifty years from 1869 to 1919, the population of the United States increased 2.76 times. In spite of the shift in population from the country to the city, so that only one quarter of those in gainful occupations were employed in agriculture in 1919, while nearly one half were so engaged in 1869, the agricultural production increased 4.94 times, or 80 per cent. more rapidly than the population. During the same fifty years, the products of mines increased 18.81 times or nearly seven times more rapidly than the population. The manufactured products increased 9.61 times, or about 3.5 times more rapidly than the population. While many factors contributed to these increased outputs, the most important factor is undoubtedly the increased production and utilization of mechanical power by machinery.

To-day, the drudgery of the struggle for existence has largely been transferred to machinery vitalized by mechanical power, thus making universal education possible by sparing youth from the farm and the factory. May we be able to maintain and even improve our material prosperity by developing more economical methods of producing and utilizing mechanical power—for our necessities of existence must be met before we can find leisure for intellectual development.

WM. L. DE BAUFRE
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ON THE BASIS FOR THE PHYSIOLOGICAL ACTIVITY OF CERTAIN ONIUM COMPOUNDS[1]

I. INTRODUCTORY PAPER[2]

THE problem of determining the basis for the physiological activity of any substance presents almost insuperable difficulties in the present state of our knowledge of the physics and chemistry of the living cell. In fact, there are those who feel that the problem is not solvable at all, until definite knowledge of living processes is available.

While it is true that a very great amount of work has been done in attempts to determine relationships existing between physiological activity and chemical structure and a number of interesting generalizations within restricted fields have been made, still from all this work substantially nothing has come to light concerning the actual mechanism of the action of any particular substance in the cell. The same may be said of the results that have been obtained in attempting to correlate physiological activity with physical properties.

The difficulties involved are many sided. Some of the first obstacles encountered have to do with limitations of theory and methods of fundamental sciences. The methods of determining, particularly in a biological environment, the various physical effects, as osmotic pressure, distribution, adsorption, interfacial tension, electrical, etc., are deplorably inadequate.[3]

Much, in fact most, of the work done in attempts to deduce correlations with physiological activity has been carried on with substances of rather intricate structures by changing groups involving only a small fraction of the mass of the complex molecule. The effect of this alteration of "side chains" on stability, tautomerism, physical properties, etc., might have been either overlooked or difficult to evaluate. Then, too,

[1] This problem is being carried on in cooperation with Dr. Reid Hunt, of the Harvard Medical School. The physiological data is the basis of another series of papers published elsewhere by him.

[2] Adapted from a lecture given before the New York Section of the American Chemical Society, June 6, 1924.

[3] One can hardly refrain from expressing regret that so few of the better minds in physical chemistry and physics have become interested in the biological applications of their fields.

it would appear that very often the type of physiological activity selected for study has not been that which could be of value from the point of view of mechanism. This is well illustrated in the work on narcotics. General narcosis is entirely too gross an action to be of value in the study of relationship with structure or even physical properties excepting only when members of a homologous series are compared. To appreciate this fully one needs to know hardly more about that subject than that narcotic action can be brought about with nearly equal facility by substance differing in chemical structure and physical properties, as do magnesium chloride, chloroform, benzyl alcohol, sulfonal and cocaine. These substances have altogether too many points of dissimilarity.

Notwithstanding the great difficulties that must be overcome in the solution of this problem and irrespective of the certainty that much of the work on it would yield results of negative value only, it still seems abundantly worth while. The urge for a carefully planned systematic study is of course evident. Until something definite is known concerning the mechanism of the action of drugs, there will be available neither a rational basis for the treatment of a large class of diseases, nor will there be a foundation from which one can systematically develop new curative agents. Without a knowledge, too, of how neurotic drugs act, there can be no true picture drawn of the action of the hormones which delicately balance the processes of normal life.

Evidently in a problem in which there is so much of the intangible, in which the difficulties are enhanced so largely by faulty methods and imperfect theory and in which there must necessarily be combined intimate knowledge of different sciences, it is especially desirable that the point of attack be carefully considered. Probably the problem will only be solved by the combined and coordinated efforts of experts in several sciences.

It would seem that attention should be given first of all to the physiological response to be investigated. This should be as definite as possible and not be given by varied classes of compounds. The substances, too, which are to be investigated should be as specific in their action as possible, that is, within definite concentration limits they should approach as nearly as can be the ideal of acting on only one type of tissue giving a single physiological response so that there will be little ambiguity as to the seat of their action. In addition their structure should be as simple as possible.

Upon considering the foregoing, we have chosen the onium compounds of the choline type. These compounds have to an unusual degree a high product of specificity of action with simplicity of structure. The choice of this class of substance is desirable, too, because through the brilliant work of Reid Hunt[4] in America and Dale[5] in England, methods have been developed for estimating the relative action of these on different nerve tissues and a great deal of pharmacological data has been made available, particularly by Hunt.

Structurally the substances are quite simple. They are alkyl and substituted alkyl onium compounds. It has been found possible by varying the substituent in one of these alkyl groups to change the physiological activity by several thousand per cent. The most striking examples of this is the effect of acetylation of choline discovered by Hunt.

Substances of this type exhibit in general three types[6] of physiological activity. They show in a quite varying degree the curare action of paralysis of the motor nerves. This action seems to be a stoppage of the nerve impulse by the action of the substance on a mechanism which couples nerve endings with the muscle (myoneural junction). While in many ways this action is of much interest, on the whole it is produced by too wide a variety of materials to be sufficiently characteristic.

A second action is the muscarine effect which is produced by the substance when present in a definite concentration range. The most readily measured result of this is a lowering of the blood pressure. The heart is slowed by stimulating the ends of the parasympathetic nerves to this organ and this, with an analogous action on the blood vessels, causes the lowering of the blood pressure.

The third physiological response is a nicotine-like action produced by these substances in relatively higher concentrations. This is made evident by a rise of arterial pressure due to a stimulation of the nerve cells of the autonomic ganglia. The action is on the cell of the peripheral neuron.

Since these actions can be studied independently[7] and since in each case the action is on a very definite structural element of the nervous system they should lend themselves with exceptional facility to the study

[4] Reid Hunt, *Am. Journ. Physiol.*, *45*, 231 (1918), and earlier papers therein cited.

[5] Dale, *Journ. Pharm. and Exper. Therap.*, *6*, 147 (1914), and earlier papers.

[6] There are two other physiological effects which may be produced by these substances. These are, however, less well defined. They may or may not produce muscular tremors and paralysis of the ganglion cells of the autonomic system.

[7] For methods of study, see papers by Hunt (Ref. No. 4) and by Dale (Ref. No. 5).

of the mechanism of drug action. We have prepared a number of ions of the general formulas R_4M^+ and R_3 M–R′–A^+ where the Rs are alkyl and aryl-alkyl groups and where A is any substituent as – OH, – SH, – NO_2, various esters, etc. M represents elements of the nitrogen and oxygen families. With the latter only three radicals will be joined to the onium element. Selected members of these series are being studied from the points of view of their stability, and their electrical, surface tension, adsorption, etc., effects as well as in certain cases their X-ray spectra and special configuration. The various stimulating and paralytic effects on the nerve impulse have been compared by Dr. Reid Hunt.

Almost every chemical and physical property has at some time been suggested as the basis for the action of drugs on the nervous system. For the most part these speculations have been considered specifically with reference to narcotics. As applied to the action of the compounds here considered all of them are distinctly inadequate.

While this appears not to be the place to consider critically all these theories, the following observations may be made with reference to the bearing that the results we have obtained have on certain of them.

Both H. Meyer[8] and H. Fühner[9] have advanced the idea that the curare action of the quaternary compounds of nitrogen, phosphorus, arsenic, antimony and sulfur depends upon the basicity of the corresponding bases. A comparison of the earlier pharmacological data with the results of conductivity determination made by Bredig[10] on a number of the tri and tetra alkylated derivatives of these elements seemed to give some basis for this statement. Hill,[11] however, has shown that in at least one case (tetramethyl ammonium hydroxide) Bredig's results are in error, and a careful investigation by Hunt[12] of a number of our products has brought out several interesting irregularities in their physiological activity. It was found that the tetra methyl derivatives of arsenic and antimony as opposed to those of nitrogen, phosphorus and sulfur did not give the paralytic curare effect nor the stimulating nicotine effect but did give like derivatives of those elements, the stimulating muscarine action (stimulation of the parasympathetic nerve endings to the heart and of certain other organs and a dilation of blood vessels). The less alkylated derivatives of these two elements are without basic properties, but the quaternary compounds approach those of nitrogen in basicity and according to this theory should approach those of nitrogen in stopping the electrical impulse from the nerve ending to the muscle. While these and also other facts throw out the idea that their strength as bases is a factor in determining the physiological activity of these substances, still one is forced to the belief that some sort of an electrical property is involved.

All substances giving the stimulating nicotine and muscarine actions and many giving the paralytic curare effect are cations. We have recently obtained very interesting proof of the importance of the character of the electrical charge on these ions in the study of certain "betaine esters" (carbethoxy methyl-trimethyl ammonium salts and homologues and analogues). Betaine is physiologically inert because, we believe, it exists in the blood substantially wholly as the electrically inert inner salt (bipolar ion, $[(CH_3)_3 N-CH_2\,COO]^{\pm}$). It has been found that when this carboxyl group is esterified and the onium grouping becomes a cation, the striking physiological activity of choline is manifest.

The desirability of a very precise study of the electrical properties of certain of these physiologically active ions seems evident. Such an investigation is being carried on in this laboratory and a preliminary paper on mobilities has been published.[12a]

The much applied (perhaps over applied) distribution coefficient theory of Overton and Meyer has been considered only incidentally with reference to the action of these substances.[13] That the distribution coefficient (in its true physical sense) between lipoids and water can have no significance in the action of these substances is shown clearly from a study of their properties. One example may be cited illustrating this. In the stoppage of the nerve impulse from the motor nerve to the muscle tissue (curare action) the effectiveness of the tetra methyl and tetra ethyl ammonium ions stands in the ratio of 1 to 25.[14] Tetra propyl ammonium ion stands in its activity intermediate between the methyl and ethyl. With regard to the stimulating effect on the inhibitory mechanism to the heart, etc. (muscarine action) and the stimulating effect on the ganglion cells of the sympathetic system (stimulating nicotine effect) the ethyl derivative is inert, while the methyl derivative gives

[8] Ergebunisse der Physiologie, I, II, 197 (1902).

[9] Archiv. f. exp. Path. & Pharmacol., *58*, 1 (1907).

[10] G. Bredig, *Z. f. physikal. Chem.*, *13*, 289 (1894).

[11] A. E. Hill, *J. A. C. S.*, *32*, 1190 (1910).

[12] Hunt and Renshaw, *J. Pharm. and Exp. Therap.*, *25*, 315 (1925).

[12a] I. Bencowitz and R. R. Renshaw, *J. Am. Chem. Soc.*, *47*, 1904 (1925).

[13] Overton, *Z. f. physikal. Chem.*, *22*, 189 (1897). See Heffter's "Handbuch der Exper. Pharmakol.," Vol. 1, p. 565.

[14] Boehm, "Arch. f. experim. Pathol. u. Pharmakol.," *63*, 177 (1910).

these actions strongly. On the other hand, both the methyl and ethyl derivatives in larger doses gives the paralytic nicotine action on the ganglion cells.[15]

Attempts have been made to connect up the chemical properties of certain of these compounds of the choline type with the duration or evanescence of their physiological action.[16] The suggestion seemed wholly warranted from a comparison of the physiological activity with their stability toward excess of alkali as determined in a rough-quantitative way. It was found, for instance, that acetyl choline,

$$(CH_3)_3 - \underset{\underset{x}{|}}{N} - CH_2\,O\,Ac,$$

lowers the blood pressure powerfully, but the action is very evanescent. In alkaline solution it was hydrolyzed apparently quite rapidly. The nitric ester, $(CH_3)_3 - \underset{\underset{x}{|}}{N} - CH_2 - CH_2 - ONO_2$, and the ethyl ether, $(CH_3)_3 - \underset{\underset{x}{|}}{N} - CH_2 - CH_2 - O\ Et$, also gave a marked depressor effect. The action was less strong but more prolonged. These compounds showed a much greater resistance to alkali.[17]

From results obtained by Mr. Bacon and the writer[18] in a careful study of certain of the esters and ethers of choline and their analogues it seems incredible that either the rates of hydrolysis or any other conceivable decomposition can have any material bearing on the duration of the muscarine action of these substances. This investigation took up particularly the relative tendency for the onium structure to dissociate and the rates of hydrolysis at a constant pH of 7.8, very slightly higher than that of blood (7.4), and at 37° C. Under these conditions acetyl choline is remarkedly stable toward hydrolysis. Only one seventh was hydrolyzed after three and one half hours. The sulfur acetyl formo choline $(CH_3)_2$ $S - CH_2O$ Ac, having not more than about one six hundredth the depressor effect and not greater evanescence was hydrolyzed approximately 125 times as rapidly. The nitric ester was hardly hydrolyzed at all after 150 minutes. Taken as a whole, the results showed that some derivatives did and some did not follow the principle suggested by Dale. While it is true that the conditions under which these rates of hydrolysis were determined are similar to those in the blood only in regard to the effective concentration of hydroxyl ion and temperature, and while it is conceivable that the order of the rates of hydrolysis by an esterase on these derivatives might be different from the order of the rates of hydrolysis by the hydroxyl ion, still, so far as the writer is aware, there is no case known where the rate of hydrolysis of an ester by an enzyme is appreciably greater than the rate by which the same will be hydrolyzed by hydroxyl ion. To explain, then, the evanescence action of acetyl choline by rapid hydrolysis due to an esterase, it would be necessary to assume an unheard-of rate for the esterase as compared with hydroxyl ion, as well as very greatly different rates for *similar* acetic acid esters.

In order to explain this variation in duration of the action it is necessary to assume, after some factor (as spacial configuration) making possible a selective adsorption has come into play,[19] some other factor or factors determining the varied rates at which these different substances exert their action on the same element of the nervous system.[20]

The well-known hypothesis of Clowes,[21] which suggests that the changes in permeability of protoplasm involves the varied tendencies of the ions of different electrolytes to reverse the phases of the natural emul-

[15] Dale, *Journ. Pharm. and Exp. Therap.*, *6*, 417 (1914–5).

[16] Dale, Ref. No. 5. See also, Ewins, *Biochem. Journ.*, *8*, 44 (1914); Fourneau and Page, Bull. Soc. Chem., *15*, 544 (1914).

[17] It was this same consideration, wholly warranted at the time, which earlier led Hunt and Menge to a study of the preparation of acetyl derivatives of substituted cholines in the hope of obtaining a less readily hydrolyzed ester and, therefore, one giving more prolonged action. They were amply rewarded in obtaining the more stable acetylmethyl choline which when given in a single injection of a few tenths of a milligram kept the blood pressure uniformly lowered to one half of its original value for hours.

[18] A paper describing this work is ready for publication.

[19] As will be shown later, physiological, chemical and physical evidence all point strongly to varied specific adsorptions as being the primal or threshold process involved in the different types of action of these substances. This may or may not be the cause of the varied duration of the same action. Whether or not the varied action is due to differences in physical properties or (and) to different spacial configuration of the drugs and to different structures or (and) environment of the tissue at the seat of action are the real fascinating questions in this interesting problem.

[20] There may be involved differences of rates by which another substance is displaced by these materials through adsorption. Many such cases are known. As Reid Hunt has recently suggested a factor which also should be considered is the rapidity with which the substances are excreted. Some may get out of the blood through the kidneys much more rapidly than others.

[21] G. H. A. Clowes, *J. Phys. Chem.*, *20*, 407 (1916).

sions, has been extended (?) to explain the stimulation or blockage of the nerve impulse brought about by a particular drug.[22] It seemed impossible to apply the theory to explain the action of these onium ions, at least, unless there is interposed some selective threshold process. These ideas were especially attractive on account of their simplicity and apparent reasonableness. Seifriz,[23] however, in a study of systems which probably more nearly approach the natural ones, has shown that the phenomena are not so simple as they were first thought to be. This fact, nevertheless, may be a fruitful discovery, since when one takes into account the physiological effects involved one must believe that the factors concerned are distinctly complex. Those who would attempt to explain the action of drugs on the nervous system by an application of simple physical effect would do well to keep in mind the physiological aspects of the problem. In addition to a number of facts already indicated further emphasis on this thought is supplied by the varied action of certain acyl derivatives of choline. As has been indicated the acetyl choline ion, $[(CH_3)_3 - N - CH_2\ CH_2O\ Ac]^+$, powerfully stimulates the action of the inhibitory nerves to the heart by an action on the endings of these nerves to that organ. The chloro and phenyl acetyl choline ions[24] also stimulate the same inhibitory nerves to the heart, but the seat of the action with them is in part in the brain instead of on the heart. That is, with these very similarly constituted ions, the action has been shifted to a considerable degree to a part of the same nerve in the brain.

Some of the most interesting suggestions that have been made in recent times concerning the mechanism of the nervous impulse have involved connecting up varying concentrations of hydrogen ions with varying permeability.[25] We are not in a position yet to discuss the bearing of our results on these suggestions.

One finds if anything even more striking similarities and dissimilarities in the physiological actions of the methyl and ethyl onium ions of nitrogen, sulfur, phosphorus, arsenic and antimony[26] than of some of the simple inorganic ions. It seems obvious that the strange difference found in the latter class (as, for example, Na^+, K^+ and NH_4^+) can be explained fully only when the structure of these ions has been elucidated. At present this field of knowledge is too speculative to warrant an attempt to apply it. Nevertheless, it is not inconceivable that the structural factor or factors causing these differences in the action of the inorganic ions may be so magnified in the onium ions as to be evaluated. In cooperation with Dr. W. P. Davey an investigation has been started to determine if a relationship can be found with such structures as can be adduced from X-ray studies.

It has long been thought that the onium element, per se, had no determining significance qualitatively in the curare action. That this was based in part on erroneous experimental evidence seems clear from Hunt's recent results[27] showing that the tetra methyl onium ions of arsenic and antimony do not give this effect in the relatively high concentrations used. (A great many different substances give the curare effect in extreme concentrations.) Evidence from the present investigation shows clearly that for the muscarine effect also the onium element is inconsequential qualitatively. We have prepared the phosphorus analogue of choline, $(CH_3)_3 \frac{P}{Cl} CH_2CH_2OH$, and Hunt has shown that it gives the typical muscarine effect of choline. Moreover, on acetylation of this product a much increased action was found by Hunt, just as he had earlier shown that this occurs with choline itself. The acetyl sulfur formocholine ion $[(CH_3)_2\ S{-}CH_2O\ Ac]^+$, too, like the acetyl choline, gives this action more strongly than does choline.

It is clear from the previous statement concerning the properties of the methyl and ethyl derivatives of nitrogen that the character of the alkyl group has great significance. This was shown also a number of years ago by Hunt and Taveau[28] in an examination of over seventy homologs of choline. They found that when other alkyl groups were substituted for the methyl groups in the choline structure the muscarine effect on the blood pressure was either absent or only slightly developed. Hunt at that time suggested that the rôle of the group, $(CH_3)_3 - N - CH_2 - CH_2 - \underset{\displaystyle X}{\underset{|}{O}}$ "is probably to carry the compounds to definite cell struc-

[22] J. S. Hughes and H. N. King, SCIENCE, *57*, 590 (1923); but see, also, Alexander Forbes, *ibid.*, *58*, 49 (1923).

[23] W. Seifriz, SCIENCE, 57, 696 (1923); *Am. J. Physiol.*, 66, 124 (1923).

[24] Hunt and Taveau, Hygienic Laboratory Bull., *73*, 28 (1911); Hunt and Renshaw, Ref. No. 13.

[25] Dorothy Haynes, *Sci. Progress*, 18, 223 (1923); E. Q. Adams, *J. Phys. Chem.*, *26*, 639 (1922); R. S. Lillie, *Physiol. Review*, 1922, p. 2; further references will be found in these papers.

[26] The ethyl derivative and many important methyl derivatives of the last four elements either have not been investigated adequately heretofore or not at all. A number of these are now being prepared and studied.

[27] Hunt and Renshaw, Ref. No. 13.

[28] Hunt and Taveau, Hygienic Laboratory Bull., *73*, 1911, U. S. Public Health Service.

tures or, to use the comparison of Ehrlich, to make them fit in a certain mosaic . . . ."

It would seem from the data now available that the least unsatisfactory working hypothesis is that the initial or threshold process in the action of these compounds involves a selective adsorption due to definite spacial configuration of at least a part of the onium ion.

Several papers will appear shortly describing the synthesis, chemical properties and physical effects of a number of these onium compounds.

Summary

(1) An outline is given of an extended, cooperative investigation now being made on the basis for the physiological activity of onium compounds on the nervous system.

(2) Evidence has been obtained which shows that the process is much less simple than is indicated by a number of theories that have been advanced to explain drug action.

(3) It would appear that the action of these substances is not due either to their chemical decomposition, their activity as bases or to their distribution coefficients. The mobility of their ions is not, at least, of primary significance. To be physiologically active, these substances must exist in the body fluids as cations.

(4) Indirect evidence is given of the necessity of taking into account the probable differences of structure of the mechanism of the nervous system on which these substances act, or (and) the environment at the seat of action.

(5) The probability that the first determining factor in the action of these compounds is something in the nature of a selective adsorption depending on the spacial configuration of the groups involved in the ion structure is suggested.

The author wishes to express his appreciation to the directors of the Bache Fund of the National Academy of Science for grants made to aid the experimental work of this investigation.

R. R. Renshaw

New York University

SOME FACTS IN THE LIFE OF THOMAS NUTTALL

The sketches of Thomas Nuttall afford nice evidence of the persistence of error. Nearly all of them repeat mistakes either relative to his journey up the Missouri or about his return from his transcontinental trip.

The first and still the most extended sketch of his life was written by Elias Durand and read March 16, 1860, before the American Philosophical Society and published in their Proceedings, Volume 7, pp. 297 to 315. Durand places the trip up the Missouri in 1910 and dates his return to Boston from California in October, 1835.

The next significant article, anonymously appearing in the *Popular Science Monthly,* Vol. 46 (1895), pp. 689 to 696, seems to be entirely dependent on Durand and to repeat his mistakes. About the same time appeared the article in the Dictionary of National Biography; here the Missouri expedition was correctly dated, but a new variant was introduced in dating Nuttall's arrival in America in 1807; elsewhere the date is given as 1808.

The American Encyclopedia gave the date of the Missouri trip as 1810. The article in the *Popular Science Monthly,* Vol. 4, pp. 52 to 57, gives the correct date for the Missouri trip but repeats for the most part the vague or incorrect statements of Durand.

Curiously enough, precision in both cases is possible because journal accounts have been published both of the Missouri trip and of the return from California. Still more curious, the error in the Missouri date is due to Nuttall's own inaccuracy, thrice repeated in his autobiographical notes found in his geological (not geographical, as given by Durand) structure of the Valley of the Mississippi, a paper read in December, 1820, and printed in the *Journal* of the Academy of Natural Sciences, Vol. I, pp. 14 to 52. Nuttall presumably depended on his memory, in this case in error by a year. On page 24 he writes: "While ascending the Missouri in the summer of 1810." Again on page 31: "On our voyage up the Missouri in 1810." Again on page 52: "Which Mr. Bradbury and myself examined in 1810," referring to the red granitic rock seen in the vicinity of the Sioux River.

This last remark serves beyond any doubt to identify this ascent of the Missouri as that taken with the Astor party. Now of this trip we have Bradbury's account, "Travels in the Interior of America," in the years 1809, 1810, 1811, second edition, London, 1819; reprinted in "Early Western Travels," Vol. V, 1904; also Brackenridge's account, "Journal of a Voyage up the Missouri" performed in the year 1811, second edition, Baltimore, 1816; also reprinted in "Early Western Travels," Vol. VI, 1904. There is, besides, Irving's "Astoria," based on the narratives of Bradbury and Brackenridge and the journals and documents of the Astor party itself.

From these accounts it is clear that Nuttall and Bradbury left St. Louis early in January, 1811 (not 31 December, 1809, as in Durand). Bradbury and

Brackenridge returned to St. Louis July 29, Nuttall remaining to come down with Lisa somewhat later. Durand has a confused idea as to this trip. Nuttall traveled wholly by water, except for walking and other short excursions; Bradbury traveled from the Arikara villages on horseback to Fort Mandan. Durand states that they crossed the Kansas and Missouri rivers as if they were journeying by land; he says also that "they reached the Mandan villages . . . ascended still higher the Missouri River." Now the Mandan villages or, more exactly, Fort Mandan, about six miles above the villages, were the extreme limit of their ascent of the river. Durand also tells of robbery by the Indians; he must have depended on recollection of oral accounts in which perhaps experiences in other trips were confused with this ascent of the Missouri.

According to Durand, Nuttall returned to Philadelphia early in 1811; this I suppose must have been 1812, or at most at the very end of 1811. "For eight consecutive years he remained in Philadelphia occupying his summer months in botanical excursions." What consecutive means when residence was broken by summer expeditions it is hard to see. Moreover, the years must be reduced to less than seven; for according to Durand himself, basing his remark on Nuttall's account of his Arkansas expedition, Nuttall left Philadelphia October 2, 1818.

The other error is not only one of date but of movement. Nuttall accompanied Wyeth in his second trip across the continent. For this trip he arrived in St. Louis March 24, 1834. Of this expedition also we have a journal record, by J. K. Townsend, an ornithologist who accompanied Nuttall: "Narrative of Journey across the Rocky Mountains," Philadelphia, 1839, also reprinted (in part) in Thwaites's "Early Western Travels," Vol. 21. According to Durand and most others who have written of Nuttall, Nuttall separated from Townsend and returned to Boston in 1835. To quote Thwaites, in his preface to Nuttall's "Journal of Travels into the Arkansas Territory," for Thwaites also is in error; most curious of all, even after editing both Bradbury and Brackenridge, he still places the trip up the Missouri in the year 1810: "Nuttall and Townsend . . . arrived in the Sandwich Islands January 5, 1835. Two months later, leaving Townsend, Nuttall sailed to the California coast, where he passed the summer, returning thence to the Sandwich Islands and embarking for Boston by way of Cape Horn." Thwaites does not give the date of his arrival in Boston; according to Durand the date was October, 1835.

Now the reprint of Townsend omits the entries relative to the Sandwich Islands, but enough is given to correct the foregoing. For Nuttall returned to the Columbia, not to California, in 1835; he was there with Townsend during that summer and until some time in September. "A few days ago," writes Townsend under date of October 1, 1835, "Nuttall took passage for the Sandwich Islands."

Now from Dana's "Two Years before the Mast," we are able to date Nuttall's return to Boston; for he returned in the same ship with Dana. Nuttall embarked at San Diego, May 8, 1836. "He had traveled overland to the Northwest coast, and came down in a small vessel (probably from the Sandwich Islands) to Monterey. There he learned that there was a small ship about to sail for Boston, and taking passage in the *Pilgrim* he came slowly along, visiting the intermediate ports and examining the trees, plants, earths, birds, etc., and joined us at San Diego shortly before we sailed." Dana speaks of Nuttall again at Cape Horn. The ship reached Boston September 20, 1836.

Nuttall made a good many other excursions; of these for the most part we have only the most general account. In his "Observations on the geological structure of the valley of the Mississippi," 1820, he tells us of his first journey to St. Louis. In the summer of 1809 he made a pedestrian tour around the greatest part of the southern shore of Lake Erie to Detroit, thence by canoe along the coast of Lake Huron and Michigan to Green Bay; thence by the Fox River and Ouisconsin, which disembogues itself two miles below the village called Prairie du Chien; thence to St. Louis. One would infer that he remained in or about St. Louis until he joined the Astor party early in 1811. But if he did so, he would pretty certainly have been associated with Bradbury, who was exploring that region in 1810. There appears to be no record of such companionship.

We learn also that he made excursions in New Jersey and along the coast southward to the Carolinas, but particulars are lacking. Certainly he traveled much in gathering his data for the "Sylva."

It might be worth while to set down a chronological table of such facts as are known:

Thomas Nuttall (1786–1859).

Son of Jonas Nuttall, printer.

Early studied botany, Dic. Nat. Biog.

To Philadelphia, Mch., 1808 (1807, Dict. Nat. Biog.).

Botanical studies began, so Durand, under Dr. B. S. Barton.

1909, to St. Louis, by way of the Great Lakes, Green Bay, the Wisconsin and Mississippi Rivers.

1811, ascent of the Missouri as far as the Mandans, with Bradbury.

1812 to 1818, Philadelphia, with summer excursions, probably along the coast from New Jersey to the Carolinas.

1817, member of the Academy of Natural Sciences, Durand.

1818–9, journey through the Arkansas country, reaching New Orleans February 18, 1820.

1820–2, Philadelphia; preface to Arkansas Journal signed there November, 1821.

1822–34, Curator of the Botanic Garden, Harvard; resigned to join Wyeth.

1834. Wyeth's caravan began march from Independence, April 28, 1834; reached Vancouver, Wash., September 16, 1834; December 3, 1834, Nuttall embarked for Sandwich Islands; returned to Columbia; reembarked for Islands last of September, 1835; coast of California winter and spring of 1836; embarked at San Diego May 8, 1836, reached Boston September 20, 1836.

1836 to 1842, Philadelphia.

1842 inherits an estate at Nutgrove, Lancashire. There until his death, September 10, 1859, except for the last three months of 1847 and the first three of 1848.

He must have made many journeys, no account of which has been preserved; as, for example, in preparation of his "Ornithology," 1832, 1834, and for his supplement to Michaux's "Sylva," 1842–9.

Asa Gray in 1844 (quoted Dict. Nat. Biog.) said: "No botanist has visited so large a portion of the U. S." He visited nearly all the states of the union and made more discoveries than any other explorer of the botany of North America.

WM. H. POWERS

SOUTH DAKOTA STATE COLLEGE

SCIENTIFIC EVENTS

THE INTERNATIONAL INSTITUTE OF INTELLECTUAL COOPERATION

THE International Institute of Intellectual Cooperation to foster and aid cooperation between the intellectual workers of all nations will open its doors on November 1 in Paris under the auspices of the League of Nations. Financial support of the institute to the extent of 2,000,000 francs a year has been pledged by the French government and the offices will be in the Palais Royal.

The following appointments have been made to the staff of the institute: Professor Gerhart von Schulze-Gaevernitz, of the University of Freiburg-in-Breisgau, who will be chief of the section on bibliography and scientific relations; Mlle. Gabriela Mistral, formerly director of the Normal School for Girls, Santiago, Chile, will supervise the literary relations of the new organization; Professor Alfred Zimmern, Oxford University, England, chief of general relations; Professor O. de Halecki, University of Warsaw, Poland, chief of university relations; Senor de Villalonga, Spain, chief of legal relations; Professor Dupierreux, Academie des Beaux-Arts of Antwerp, chief of art relations; Signor Giuseppe Prezzolini, Italian publicist, chief of information.

The governing board of the new institute consists of the League of Nations committee on intellectual cooperation whose membership includes Einstein, Bergson, Millikan, Hale, Mme. Curie, Gilbert Murray, Lorentz, Kellogg, and other leaders in science, literature and the arts.

National Committees on Intellectual Cooperation in many countries have been organized to aid the International Institute and the League Committee in its work. In the United States a committee has been formed with Dr. Robert A. Millikan, president of the California Institute of Technology, as chairman. This group, merging for the first time in a formal way the scientific, artistic, literary, legal, educational and other learned activities of the country, will collaborate with the International Institute of Intellectual Cooperation and the League of Nation's Committee on Intellectual Cooperation.

The first meeting of the American Committee on International Intellectual Cooperation will be called early this winter. The membership includes: Dr. Millikan; Elihu Root, past president of the American Bar Association; George E. Hale, honorary chairman of the National Research Council; Charles H. Haskins, chairman of the Council of Learned Societies; Herbert Putnam, librarian of Congress and past president of the American Library Association; Virginia C. Gildersleeve, president of the International Federation of University Women; Lorado Taft, member of the American Academy of Arts and Letters; James H. Breasted, representative of American philological organizations; Charles W. Eliot, president emeritus of Harvard University, representative of American universities; Augustus Trowbridge, International Education Board; C. R. Mann, director of the American Council on Education, and Vernon Kellogg, permanent secretary of the National Research Council, secretary of the committee.

FIRST MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

THE first meeting of the American Society of Parasitologists will be held in Kansas City from December 29 to 31, 1925, in association with the meeting of the American Association for the Advancement of Science. The parasitologists is a new society which was organized at the Washington meeting last year. Its purpose is to bring together those groups interested in animal parasites. Its membership in-

cludes, therefore, protozoologists, helminthologists and entomologists, who have interest in the general problems of parasitology or in the medical or veterinary phases of the subject. The society is affiliated with the American Association and is related to both Section F (zoological sciences) and Section N (medical sciences). Any one interested in any of the phases of parasitology is eligible for membership. The membership of the society has already passed the two hundred mark.

Every attempt is being made to make the meetings of the society at Kansas City thoroughly representative. Features of the program will be the address of the retiring president, Professor Henry B. Ward, and a joint symposium with Section N of the American Association, on the "Medical aspects of parasitology," which will be held on the afternoon of Wednesday, December 30. In addition there will be programs for the presentation of papers by members of the society. All members of the American Association and others who are interested are cordially invited to attend the meetings of the society.

SEMI-CENTENNIAL OF THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THIS year is the fiftieth anniversary of the beginning of agricultural experiment stations in this country. The first station was started in Connecticut in 1875, with an appropriation of only $3,000, part of which was from private sources. It was located at Wesleyan University, Middletown, under the direction of Dr. W. O. Atwater, but two years later the legislature reorganized the station and transferred it to New Haven, Dr. S. W. Johnson, of Sheffield Scientific School, being placed in charge as director.

The semi-centennial of this station was observed with appropriate ceremonies on the station grounds at New Haven, on October 12. It was attended by representatives from the experiment stations in the northeastern section, the U. S. Department of Agriculture, the Association of Land-Grant Colleges, Yale University, and other persons interested in the work of the station. Governor Trumbull, president of the station board of control, presided and gave a brief address on "The agricultural experiment station and the state." He was followed by addresses on "The relations of the federal government and the states in agricultural research," by Dr. E. W. Allen, chief of the Office of Experiment Stations, and "The influence of experiment stations on American agriculture," by Dr. R. W. Thatcher, director of the New York Experiment Stations. An excellent portrait of Dr. E. H. Jenkins, who recently retired from the directorship of the station, was presented on behalf of his friends by Dr. Henry S. Graves, provost of Yale University. In the evening a complimentary dinner was tendered Dr. Jenkins and his contemporaries, which was largely attended. Numerous speakers extolled the work of the station and its founders, and paid high tribute of appreciation and affection to the leading figure of the occasion.

E. W. ALLEN

WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM H. WELCH, director of the school of hygiene and public health at the Johns Hopkins University, has been awarded the first W. W. Gerhard gold medal of the Pathological Society of Philadelphia.

DR. THEODORE W. RICHARDS, professor of chemistry at Harvard University and director of the Gibbs Memorial Laboratory, has been decorated with the insignia of an officer of the Legion of Honor by the French government.

PROFESSOR S. W. PARR, of the University of Illinois, was awarded the honorary degree of doctor of science by Lehigh University on October 7. The occasion was the sixtieth Founder's Day exercises of the university at which Professor Parr was the principal speaker.

DR. E. V. MCCOLLUM, professor of biochemistry in the school of hygiene and public health of the Johns Hopkins University, and Dr. George Sarton, associate of the Carnegie Institution and editor of *Isis*, have been elected to membership in the Kaiserliche Deutsche Akademie der Naturforscher Halle.

THE Russian Geographic Society has elected Dr. William Bowie, chief of the division of geodesy of the U. S. Coast and Geodetic Survey, a corresponding member of the society in recognition of his work in isostasy and other branches of geodesy.

PROFESSOR ARTHUR M. MILLER, for thirty-four years head of the department of geology at the University of Kentucky, by action of the board of trustees of the university, on June 30 was retired as professor emeritus of geology. Continued ill health for the past three years, rendering him unable to engage in active teaching was the reason for the board's action. As the university has no pension system, Professor Miller is retired without pay.

PROFESSOR W. CARMICHAEL M'INTOSH, F.R.S., emeritus professor of natural history in the University of St. Andrews, celebrated his eighty-seventh birthday on October 10.

DR. JAMES F. NORRIS, professor of chemistry at the Massachusetts Institute of Technology and president of the American Chemical Society, was a guest of the Chicago Chemists' Club on September 15, at a special luncheon.

DR. C.-E. A. WINSLOW, professor of public health and hygiene at Yale University, was elected president of the American Public Health Association at the St. Louis meeting.

PRESIDENT A. LAWRENCE LOWELL, of Harvard University, was selected chairman of the commission on medical education at the opening session in Buffalo. Dr. Willard C. Rappelye, professor of hospital administration at Yale University, will devote all his time to a five-year survey of the curricula of American medical schools.

DR. D. ROBERTS HARPER 3d, physicist in the Bureau of Standards, has resigned to take charge of some heat measurements in the general engineering laboratory of the General Electric Company at Schenectady. Dr. Harper has been stationed in New York as the liaison officer of the Bureau of Standards with the American Engineering Standards Committee.

RALPH C. HARTSOUGH, of the department of physics at Columbia University, has been appointed to a position with the Western Electric Co., Chicago (Hawthorne works), as research physicist.

DR. GEORGE H. BIGELOW, deputy commissioner of health for Massachusetts, has been appointed commissioner of health to succeed the late Dr. Eugene R. Kelley.

DR. RUSSELL W. MILLAR, assistant professor of physical chemistry at the University of California, Southern Branch, recently resigned his position to join the research staff of the Bureau of Mines at Berkeley, Calif.

J. M. BRAHAM, of the Fixed Nitrogen Research Laboratory, Department of Agriculture, has been appointed to the research department of the Atmospheric Nitrogen Corporation, Syracuse, N. Y.

DR. FRANK E. E. GERMANN, of the University of Colorado, has been granted sabbatical leave for the year 1925–26 and will be associated with the Carnegie Institution of Washington, doing research on the fluorescence of the platinocyanides in cooperation with Dr. Edward L. Nichols, emeritus professor of physics at Cornell University.

DR. H. M. ELSEY, associate professor of physical chemistry at the University of Kansas, has been granted leave of absence for the coming year and will be associated with the Research Department of the Westinghouse Company of Pittsburgh.

DR. W. K. FISHER, of the Hopkins Marine Station, Pacific Grove, California, will spend November and December visiting eastern biological laboratories.

PROFESSOR HARRY N. HOLMES, head of the department of chemistry at Oberlin College, has been granted a leave of absence for the present academic year. Dr. Holmes will spend the year in study and travel abroad.

E. WILLARD BERRY, son of Professor Edward W. Berry, of the Johns Hopkins University, sailed from New York on October 29 for three years' geological work in Peru with headquarters at Negritos.

DR. F. E. TROTTER, president of the board of health of Honolulu, has gone to Tokyo, under the auspices of the Pan–Pacific Union, to be Hawaii's official delegate at the conference of the Far Eastern Association of Tropical Medicine, which is being held there from October 11 to November 1.

DR. JOHN NORTHROP, of the Rockefeller Institute for Medical Research, will deliver the second Harvey Society Lecture at the New York Academy of Medicine on Saturday evening, November 14, at eight-thirty. His subject will be "Pepsin and trypsin."

DR. HARVEY W. WILEY addressed the Lions Club of Atlantic City at the Elks' new home, on October 21, on the subject, "Do you want to live a little longer?"

DR. RICHARD P. STRONG, of the department of tropical medicine of Harvard University, delivered an address upon the subject of "Spirochaetal infections of man," at the seventy-fifth anniversary meeting of the Medical Society of the State of Pennsylvania, held at Harrisburg from October 6 to 8.

DR. HENRY E. CRAMPTON, professor of zoology in Barnard College, Columbia University, is delivering a series of four lectures on "The evolution of life," at the Rand School of Social Science.

PROFESSOR J. W. GREGORY, F.R.S., delivered his presidential address to the Westminster and Central London Branch of the Geographical Association on September 30, on "The relative influence of denudation and earth-movements in moulding the surface of the earth."

DR. HENRY H. ROBINSON, Ph.D., Yale, superintendent of the Connecticut Geological and Natural History Survey since 1920, died on October 20, at the age of fifty-two years.

DR. C. F. SONNTAG, prosector to the Zoological Society of London, died on October 10, aged thirty-seven years.

CAPTAIN H. RIALL SANKAY, of England, past president of the Institution of Mechanical Engineers and an authority upon steam and gas engines, died on October 3, in his seventy-second year.

S. J. JOHNSTON, formerly professor of zoology in the University of Sydney, Australia, died on July 16.

PROFESSOR H. H. HILDEBRANDSSON, the well-known Swedish meteorologist, recently died at the age of eighty-seven years.

PROFESSOR A. A. FRIEDMANN, director of the Central Geophysical Observatory of Russia, died on September 16, aged thirty-seven years.

ACCORDING to the *Journal* of the American Medical Association, the foreign guests at the fifteenth annual meeting of the clinical congress of the American College of Surgeons, Philadelphia, which takes place from October 26 to 30, will be Lord Dawson, of Penn, London, physician in ordinary to the king; Sir William Arbuthnot Lane, London, who will deliver the John B. Murphy oration in surgery; Professor Vittorio Putti, Bologna, Italy, who will speak on some phase of orthopedic surgery; Dr. Victor Pauchet, of Paris, professor of clinical surgery in the School of Medicine at Amiens, will read a paper on "Experiences in the surgical treatment of gastric, duodenal and jejunal ulcers"; Dr. William Blair-Bell, professor of obstetrics and gynecology at the University of Liverpool, England, and Dr. Philip J. Franklin, London, eye, ear, nose and throat surgeon to the East London Hospital. Headquarters will be at the Bellevue-Stratford Hotel. At the meeting on Monday evening the president of the congress, Dr. Charles H. Mayo, Rochester, Minn., inducted into office his successor, Dr. Rudolf Matas, of New Orleans.

THE Rochester Section of the American Chemical Society, in cooperation with the division of organic chemistry, will hold a symposium on organic chemistry in Rochester on December 29, 30 and 31. A number of the leaders in various branches of organic chemistry have been invited to present papers at the symposium. Ample time will be allowed for the presentation and discussion of the papers. This will make possible the presentation of papers of greater general interest to organic chemists than those which can be presented at the regular meetings of the division. All who are interested in organic chemistry and can attend the symposium are cordially invited to do so. Further particulars can be obtained from E. M. Billings, *secretary,* Rochester Section, Eastman Kodak Co., Rochester, N. Y., or F. C. Whitmore, *secretary,* division of organic chemistry, Northwestern University.

THE annual meeting of the Eastern Society of Anesthetists is being held at Philadelphia from October 26 to 30 at the Hotel Adelphia. There will be clinics in the mornings and discussions open to members of the profession in the afternoons, also joint sessions with the Mid-Western Association of Anesthetists, the Philadelphia Academy of Stomatology and the American Society of Regional Anesthesia. The dinner-dance was held on October 28. Dr. Adolph F. Erdmann delivered the president's address on October 26.

THE New York State Association of Public Health Laboratories will hold its mid-year meeting on Wednesday, November 4, at the State Laboratory in Albany. There will be a morning and an afternoon session at which papers will be presented and opportunity given for general and informal discussion.

THE fifth annual conference of health officers and public health nurses will be held in Lansing, Michigan, on November 18, 19 and 20, under the auspices of the Michigan Department of Health and the Michigan Public Health Association.

MAYOR BEHRMAN, of New Orleans, has issued formal invitations to a conference to the mayors of thirty cities in Louisiana, Mississippi and Alabama and to the presidents of police juries in fourteen parishes in Louisiana, to make plans for a comprehensive survey to determine the best methods of attacking the problem of marsh mosquitoes. Governor Fuqua has issued invitations to the conference to the governors of adjoining states, the secretary of agriculture, the surgeon general, U. S. Public Health Service, and other federal sanitation experts.

AT the twenty-eighth annual convention of the American Bakers' Association held at Buffalo from September 15 to 18, the organization of a department of nutritional education in the American Institute of Baking, and the subscription of $100,000 in five installments of $20,000 a year toward financing the work of the department by the Robert Boyd Ward Fund, Inc., were announced. The contribution of $100,000 is without any conditions, the particular use of the money being left entirely to the determination of the directors of the institute. In the letter of Mr. W. B. Ward, president of the Robert Boyd Ward Fund, Inc., transmitting the first installment of $20,000, he expresses the hope that the idea of such a department may appeal to others in the industry and its allied trades so as to result in its further expansion and "that the work in the education and science of nutrition will redound to the credit of the industry as a whole."

A NEW type of institute was recently dedicated at Göttingen as the sixteenth institute of the Kaiser Wilhelm Society for Advancement of the Sciences. According to *Industrial and Engineering Chemistry,* this institute is to study all manner of air and water currents in free flow, in connection with airships, me-

teorological problems, the influence of currents on living organisms, etc. Although it has primarily no direct relation to chemistry, nevertheless various questions which will be submitted to the institute may be of significance to chemical technology as well. Apparatus of an entirely novel type has been erected, for example, a large wind chamber pumped free of air, into which can be introduced powerful air currents of a velocity even greater than that of sound.

THE cornerstone of the new building of the New York Academy of Medicine will be laid on October 30, at 4:30 o'clock. According to the *Journal* of the American Medical Association, from 1843 until 1924 the academy limited its activities to promoting the science and art of medicine, to the maintenance of medical library and the promotion of public health. When it decided to expand, the Carnegie Corporation appropriated $1,550,000 for a new academy building and the Rockefeller Foundation $1,250,000 for endowment for new activities, including the appointment of a full-time director and a new executive librarian, the development of library service, the maintenance of a bureau of clinical information and the publication of a bulletin. The director of the academy, who began his duties January 1, 1924, is a member of all committees, makes special studies of affairs suggested by the council and is general superintendent of the building. The library is the only public medical library in New York City. It is open daily to the public, and the staff will be increased in order to extend its activities.

IT is reported that forty men, including carpenters, masons and electricians, left Oslo, Norway, on October 13 for Kings Bay, Spitzbergen, where they will spend the winter building a shed for Captain Roald Amundsen's polar airship. Mr. Ellsworth, Amundsen's colleague in this year's flight, has given $100,000 for the expenses of the expedition, which will be known officially as the Amundsen-Ellsworth Expedition. It will fly the Norwegian flag only. Captain Amundsen is now on a lecturing tour in the United States. His proposal is to fly in an airship next summer from Spitzbergen, by way of the North Pole, to Alaska. His experience this year has convinced him, he stated recently, that aeroplanes are not suitable for prolonged Arctic flights.

THE installation of new equipment in Professor Pavlov's physiological laboratory has been completed. The entire laboratory has been constructed according to plans worked out by Pavlov, and includes an operating department, consisting of three rooms and a clinic built in accordance with the latest requirements in clinical surgery. In one of the rooms has been installed a special sound-proof chamber for the purpose of carrying on precise experiments on the method of conditional reflexes.

MT. WATATIC has been purchased by the New England Federation of Bird Clubs and will be presented to the Commonwealth of Massachusetts for a permanent bird sanctuary. Mt. Watatic is almost the only remaining important forest area of red spruce in Massachusetts. It is located in Ashburnham and Ashby. About one hundred acres on top of the mountain were bought by the federation when it was discovered that this virgin forest was about to be invaded by the axe. Negotiations were already in progress for the sale of it to a lumber concern when it was purchased by the Federation of Bird Clubs.

Museum News states that the first unit of the new museum of the Los Angeles Museum of History, Science and Art is now practically complete and it is hoped that the new building will be thrown open to the public by November 1. This four-story unit, which has been erected at a cost of $900,000, will provide approximately three times the floor space available in the old building. Until the other units are completed the exterior will be finished in concrete. Eventually the completed museum will be surfaced with stone. The opening of the new building will be marked by the unveiling of notable new habitat groups, more especially the great African jungle groups for which the material has been gathered during the past five years by Leslie Simpson, big game hunter. Two of these groups, one of which represents a water-hole on the veldt, will be one hundred feet long. Maurice Logan, who has painted the backgrounds for these groups, went to East Africa more than a year ago to make studies and photographs and to bring back material to be used in the construction of the settings. Among the collections which will find a place in the new unit are: the Burlingame-Johnson Chinese potteries; paleontological and natural history collections; an extensive marine exhibit; the open-air gallery of garden and architectural sculpture.

AWARDS have recently been made of the four war memorial scholarships offered annually by the Westinghouse Electric and Manufacturing Company as a memorial to those employees of the company and its subsidiaries who entered the service of their country during the World War. Each scholarship carries with it an annual payment of $500 for a period not to exceed four years, such payment to be applied toward an engineering education. This year's awards go to Bernard C. Hibler, who will attend Penn State College; Robert G. Redhead, Washington University, St. Louis; William H. Hamilton, University of Pennsylvania, and Starling Winters, University of California. Thirty-six candidates in ten cities competed.

A NEW journal, *Genetic Psychology Monographs,* has been founded at Clark University in order to fulfill a need long felt by American and European psychologists. The new journal has been formed to care for research papers that are too large to be printed in regular journals. Each number is to be a complete research and may be contributed from any part of the world. The journal is edited and published by the *Pedagogical Seminary* and *Journal of Genetic Psychology,* with an international board of editors consisting of: Bird T. Baldwin, State University of Iowa; William H. Burnham, Clark University; Cyril Burt, University of London; Edward Claparède, University of Geneva; Edmund S. Conklin, University of Oregon; Arnold Gesell, Yale University; William Healy, Judge Baker Foundation; Walter S. Hunter, Clark University; K. S. Lashley, University of Minnesota; Carl Murchison, Clark University; Henri Pieron, University of Paris; Sante de Sanctis, University of Rome; William Stern, University of Hamburg; Lewis M. Terman, Stanford University; E. L. Thorndike, Columbia University; John B. Watson, New York City, and Helen Thompson Woolley, Columbia University. There will be six numbers a year, each of one hundred pages and comprising a single research work, the first issue to be out in January.

YALE UNIVERSITY has set aside 200 acres of the Ray Tompkins Memorial tract near the new golf course as a preserve for the native plant and wild life of this region. The preserve will serve as a sanctuary for animals and plants and will also be used for field studies and instruction by the departments of botany, zoology and forestry. For a long time this extensive tract of forest has been under excellent protection and care. Around a portion of it is still found the high woven wire fence which confined the deer and elk when its former owner, John M. Greist, of New Haven, used the land as a deer park. In commenting upon the project, Dean Graves, of the forestry school, said: "Characterized by a great variety of trees, shrubs and wild flowers, already a refuge for birds and animal life of interest to the zoologist, and within easy reach of the university, the preserve offers an unusual opportunity for research and for class work in the field."

UNIVERSITY AND EDUCATIONAL NOTES

THE will of the late James B. Duke, former president of the American Tobacco Co., provides $40,000,000 for Duke University, Durham, N. C., $4,000,000 of which is to be used for the establishment of a medical school and hospital. This amount is in addition to the $40,000,000 given to Duke University last December by Mr. Duke.

ANNOUNCEMENT has been made by the Board of Trustees of Princeton University of the receipt of gifts amounting to $721,085 for general endowment and of $32,300 for current expenses. The trustees also accepted from an anonymous Princeton alumnus a trust fund of $50,000.

THE Connecticut College of Pharmacy, founded by the State Pharmaceutical Association, will be opened on October 21 in the old Yale Medical School Building on York Street, which has been remodeled. A two-year course, leading to a degree of Ph.G., will be given.

DR. BASHFORD DEAN, curator of arms and armor at the Metropolitan Museum, and formerly professor of zoology in Columbia University, has been appointed professor of fine arts at New York University.

DR. JOHN RICE MINER has been appointed biometrician, with the rank of associate professor, in the Institute for Biological Research of the Johns Hopkins University.

DR. HAROLD W. MANTER, of the University of Illinois, has been appointed to the position of parasitologist in the department of zoology at the Louisiana State University, Baton Rouge.

FRANKLIN J. BACON, head of the department of pharmacognosy for Eli Lilly and Company, has been appointed head of the department of pharmacology and pharmacognosy in the College of Pharmacy at the University of Florida.

FRANKLIN SHERMAN, of the North Carolina State College, has been appointed head of the division of entomology at Clemson College, S. C.

THE following additions to the faculty of the Jefferson Medical College, Philadelphia, have been announced: Dr. Pascal Brooke Bland, professor of obstetrics; Dr. William M. Sweet, professor of ophthalmology, and Dr. Edward A. Strecker, professor of nervous and mental diseases.

DR. ARTHUR H. RUGGLES, director of the Butler Hospital of Providence, R. I., has been appointed consultant in mental hygiene to the department of university health and lecturer in psychiatry in the School of Medicine at Yale University.

ARTHUR N. BRAGG, assistant in biology in the Johns Hopkins University, has been appointed instructor in the department of zoology in Marquette University, Milwaukee.

M. RECHON has been appointed professor of electroradiology at the University of Bordeaux, to take the place of the late Professor Bergonié.

DISCUSSION AND CORRESPONDENCE

PRESSURE ENERGY IN AN INCOMPRESSIBLE FLUID AND BERNOULLI'S PRINCIPLE

PROFESSOR E. H. KENNARD in SCIENCE for September 11 gives a correct statement of the "energy transfer" formulation of Bernoulli's principle, but it seems to me that he is mistaken in his contention that the "pressure energy" point of view is absurd.

In an open body of incompressible liquid under the action of gravity the potential energy per unit volume of a given portion of the liquid is, of course, partly dependent on gravity, and it is permissible to think of it as partly due to pressure. The first part of the potential energy per unit volume is equal to hdg where h is the height of the given portion above a chosen reference level, d is the density of the liquid, and g is the acceleration of gravity; and the second part of the potential energy per unit volume is equal to the pressure p of the portion of the liquid.

Let us take the pressure at the surface of the liquid as zero so that the pressure p at any point in the liquid may be thought of as gauge pressure. Then to carry unit volume of the liquid from the surface to a place where the pressure is p an amount of work equal to p must be done in overcoming the forces exerted on the unit volume by the surrounding liquid. This work has been handed on to other portions of the body of fluid (it does not reside in the portion of fluid which has been carried from A to B), but the location of what we choose to call potential energy is never a matter for consideration. The notion of potential energy is legitimate when the work done to effect a change of configuration is a function only of the change of configuration.

It is, of course, entirely proper to consider where the work done on a portion of fluid to carry it from A to B has gone to, that is to say the energy aspects of a fluid in motion can be formulated on the basis of transfer of energy in the fluid, and there is some advantage in this method because it involves definite things which are ignored in the method in which we assign potential energy due to pressure to each portion of the fluid. Potential energy is always an idea which makes up for things ignored.

WM. S. FRANKLIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN an article on Bernoulli's theorem (SCIENCE, Sept. 11, 1925) Dr. Kennard objects to the name *pressure energy* for the so-called pressure head, and especially to the idea that a pound or a cubic foot of liquid carries pressure energy with it along a tube of flow.

The validity of the objection can not be tested conclusively by deriving the theorem from the principle of energy, because this involves the point in question. Let Bernoulli's theorem be obtained as an integral of Euler's equations in the case of irrotational, frictionless, stream-line flow; it is then merely a mathematical affair awaiting any useful and usable interpretation. Two of the terms in it are kinetic and position energy, one depending on the velocity and the other on the position of the element of liquid. The third term is energy and since it depends on pressure the name pressure energy is surely not inappropriate. Every one of the three terms varies with the mass and the position of the element; therefore each quantity of energy may at least be regarded as belonging to and traveling with the element.

Pressure energy in this sense is distinctly different from compression or elastic energy. For example, if a rod is to be used for transmitting a push P with a possible displacement p, the pressure energy possessed *by the rod* is Pp; this is like potential energy Wh. If P shortens the rod an amount e the compression energy is ½Pe. Similarly, when energy is transmitted by water flowing through a horizontal pipe, the input, omitting the kinetic energy, is p/w ft-lbs per lb, the friction loss is h_f ft ft-lbs per lb, and the output is thus $(p/w - h_f)$ vAw ft-lbs per sec. where v is the velocity of flow, A the section area of the pipe, w the specific weight of the water, and p the pressure (force per unit area) at the input end of the pipe. Problems solved in this way become simple exercises in book-keeping on the energy transactions of a pound of water.

Dr. Kennard's value of 46 ergs should be 23 ergs, because the average pressure is half of 1.031×10^6 dynes per cm.^{2}

R. F. DEIMEL

STEVENS INSTITUTE OF TECHNOLOGY

A FOSSIL FISH OF THE FAMILY CALLICHTHYIDAE

IN the fresh waters of South America north to Panama may be found small catfishes (*Hoplosternum punctatum* Meek and Hildebrand) of a peculiar type, the sides of the body covered with a double series of vertically elongated plates. They were revised by Mrs. Marion Durbin Ellis in 1913, and since then not much has been added to our knowledge. When recently collecting fossil insects in the green Tertiary rock at Sunchal, Province of Jujuy, Argentina, I was fortunate in finding the first fossil representative of the family. Although it is at least sev-

eral millions of years old, it appears to belong to the living genus *Corydoras,* and may be known as *Corydoras revelatus* n.sp. It is 27 mm long from end of snout to base of caudal fin, the total length at least 31 mm; depth at base of dorsal slightly over 9 mm; width of orbit 2 mm; orbit from top of head 1.8 mm, from end of snout 3.5 mm; lateral plates numerous, certainly over 20 in each series; dorsal spine very strong, anal spine weak. In the deep body, arched profile of head, and rather large eye it resembles *C. paleatus* (Jenyns), a species discovered by Darwin on the voyage of the *Beagle.* The eye appears to be placed lower down, but this may be the result of crushing. The opercular plate agrees with that of *C. paleatus* and other species, having the lower posterior margin concave. The dorsal spine is very heavy, suggesting *C. armatus* (Günther), but there is no evidence that the soft rays are prolonged to a point.

The discovery of this fish, together with that of the accompanying insects, shows that the variegated green and red shales of this part of Argentina belong to the Tertiary, possibly late Tertiary, and are of freshwater origin. This is a matter of considerable importance as the age of the beds was somewhat in doubt. The discovery of fossil insects in these rocks is due to Mr. Geo. L. Harrington; my wife and I visited the locality and obtained many species.

Corydoras still lives in the same region; thus *C. micracanthus* of Regan was discovered at Salta.

T. D. A. Cockerell
University of Colorado

TOBACCO AND TOMATO MOSAIC

(1) Longevity of the Virus of Tobacco Mosaic

In February, 1920, I received from Dr. H. A. Allard for comparative tests a small bottle of expressed juice from mosaic-diseased tobacco plants. It was unfiltered and protected from contamination by a layer of toluene. A small portion only was used at the time and the remainder tightly corked and set aside.

On May 25, 1925, four healthy plants were inoculated by rubbing two leaves of each with a small portion of the preserved juice. Two check plants were treated similarly, using sterile water. The plants were kept in a good light in the laboratory. On June 15 each of the four plants was definitely mosaic-diseased, while the two check plants were perfectly healthy, as they have remained to date.

On June 25 four other healthy plants six weeks old were similarly inoculated and left in the greenhouse, while check plants were again treated with sterile water. On July 10 each of the four inoculated plants was showing excellent mosaic symptoms, while checks were healthy.

It is therefore a fact that the expressed juice of mosaic-diseased tobacco plants retained *in vitro* over five years is still infectious.

(2) Streak of Tomato in Quebec a "Double-Virus" Disease

Mr. T. C. Vanterpool, working in my laboratory, has been studying "streak or stripe" disease of tomato since 1923. Diseased plants and those artificially inoculated with "streak virus" often tend to outgrow streak symptoms in the upper straggling part of the plant, but they always present mosaic symptoms in those parts. Further, the virus of tomato streak inoculated into tobacco always gave mosaic, and a transfer from that tobacco often reproduced streak in tomato. The possibility of double inoculation was therefore considered, and the following summarized facts cover the work done this season in both greenhouse and field.

Healthy tomato plants inoculated with a mixture of viruses from mosaic-diseased tomato and potato, or tobacco and potato, develop streak in about fourteen days. Mosaic-diseased tomato plants inoculated with virus from mosaic-diseased potato develop streak. Virus from diseased potato gave rise to doubtful mosaic in healthy tomato. Juice from a tobacco plant showing mosaic after inoculation with tomato and potato mixed virus developed streak when inoculated into healthy tomato.

Combinations of bean mosaic and raspberry mosaic viruses with tomato mosaic virus gave negative results.

From the above results it may reasonably be concluded that in Quebec streak or stripe of tomato is not a disease caused by *B. lathyri* but is a disease resulting from double inoculation, *i.e.,* with virus of potato mosaic and tomato mosaic (tobacco mosaic in this case being considered the same as tomato mosaic). Further work may show that other host plants function as potato, and more work is required to determine the proportions of the two juices necessary to develop streak of tomato.

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Department of Botany,
Macdonald College,
Quebec, Canada

SEX CHANGES IN BIRDS

In Science News Service, as printed in your issue of Science, March 6, 1925, appears an article relating to the changing of sex in pigeons. The observations of Dr. Oscar Riddle, of Carnegie Institution of Wash-

ington, are given and his deductions are most interesting.

Shortly after reading this article the undersigned came across an old book, printed in London in 1859. This book's title is "Ten Thousand Wonderful Things, Marvelous, Rare, Curious and Quaint." It was compiled by Edmund Fullington King, and is made up of short articles of historic, scientific and otherwise curious phenomena. On page 189 of this book appears the following account of what is described as "An extraordinary problem" with reference to the changing characteristics observed in gallinaceous birds. The article follows:

A CHANGE IN SEX

Connected with the plumage of birds is an extraordinary problem which has baffled all research, and toward the solution of which not the slightest approach has been made. Among certain of the gallinaceous birds, and it has been observed in no other family, the females occasionally assume the male plumage. Among pheasants in a wild state the hen, thus metamorphosed, assumes with the livery a disposition to war with her own race, but in confinement she is spurned and buffeted by the rest. From what took place in a hen pheasant in the possession of a lady friend of the late Sir Joseph Banks, it would seem probable that this change arises through some alteration in the temperament at a late period in the animal's life. This lady paid particular attention to the breeding of pheasants. One of the hens, after having produced several broods, moulted and the succeeding feathers were exactly those of a cock. The animal never afterward laid an egg.

The pea hen has sometimes been known to take the plumage of the cock bird. Lady Tynte had a favorite pea hen which at eight several times produced chicks. Having moulted when about eleven years old, the lady and her family were astonished by her displaying the feathers peculiar to the other sex and appearing like a pied peacock. In this process, the tail, which was like that of the cock, first appeared. In the following year she moulted again and produced similar feathers. In the third year she did the same, and then also spurs resembling those of the cock. The bird never laid after this change of her plumage.

This paragraph in this old book, printed seventy years ago, only goes to prove that there is "nothing new under the sun," although those who observed the phenomena at that day were unable to account for it to the extent that Dr. Riddle has.

I. M. HEMINGER

SAN JOSE, CALIF.

ANTI-EVOLUTION PROPAGANDA IN GEORGIA

THE following extract from the letter of a friend teaching in Georgia, one whose name carries a Ph.D. degree from the University of Wisconsin and whose reputation for veracity is excellent, may help to explain why the people of Georgia failed to support the recent anti-evolution bill brought before their legislature.

My friend with a perhaps improper curiosity had attended a negro church service during the month of July. I now quote:

> The preacher spoke somewhat as follows: "As long as they said us coluhd folks was descended from ape-like animals nobody didn't say nothing. But that's because their hearts wasn't pure. And when Darwin came along and said folks in gen'l was descended from a fossil, then nobody didn't like it. But his heart wasn't pure. And then Voltaire came along and said it too, but nobody didn't pay no attention to him because his heart wasn't pure. And then Thomas Payne came and said we was all descended from fossils. But he didn't make no headway, cause *his* heart wasn't pure. And in Tennessee, Bryan and Darrow and those folks won't do no hurt, for their hearts isn't pure. The Bible don't say we's descended from fossils."

JOHN SMITH DEXTER

UNIVERSITY OF PORTO RICO

SCIENTIFIC BOOKS

Dynamische Meteorologie. By F. M. EXNER, professor of geophysics at the University of Vienna and director of the Central Institute for Meteorology and Geodynamics. 2d Edition, much enlarged. 421 pages, with 104 figures in the text. Vienna, 1925, Julius Springer.

ANY contribution from so careful and conscientious an investigator as Exner is worth having, and the present volume should be in the hands of every serious student of what formerly was called dynamic meteorology; but is now more generally termed aerography—the structure of the atmosphere.

The book first appeared in 1916 and evidently suffered from the loss of touch with British and American progress. The war certainly did advance our knowledge of air structure, even if we consider only the instrumental side of the problem. In one of his papers before the Royal Meteorological Society (April, 1919), Sir Napier Shaw said:

> It may be that in the near future no meteorological observatory will be regarded as really complete if it does not possess a cinematograph camera, a searchlight, a range finder and a chronograph, besides a kite balloon, a gun and ammunition, and crews to use them.

There is a decided flavor of war-time experience in the above; and in time of peace we can dispense with some of these; but on the other hand there are new

instruments, particularly those connected with vapor, dust, cloud and visibility problems, which are now essential. Also every observatory should have its own airplane, or better yet a fleet of planes, and be in close touch with the travelers of the air.

Exner has included in this present edition all recent discussions on mass movements of warm and cold air streams, the various theories regarding the origin of cyclones and the behavior of air masses when in juxtaposition with sharply marked boundaries. The results of such interchange can be traced in causing or facilitating precipitation.

The latest views of the Bergen school of forecasters and the function of surfaces of discontinuity—the so-called polar front and the steering line (Böenlinie und Kurstlinie)—are given at length.

In the opening chapters on mass systems and the laws of gases, there is room for improvement and there is a departure from the C.G.S. system. While the author defines the accepted or Bjerkian bar with its thousandth part the millibar, he prefers to stick to the older unit, the pressure of a millimeter of Hg. And in a footnote regarding the distinction between mass and weight, there is a reversion to the meter-kilogram-second system. It is confusing to read about normal pressure in such units. In this respect the book is disappointing.

The opening chapters deal with the usual equations for unsaturated and saturated conditions. One is apt to get the impression that the weight of water vapor is five eighths that of dry air, forgetting that this value only holds under certain conditions of pressure and temperature. We notice also that the values of the specific heat for dry air $c_p = 0.2375$, at constant pressure and the same for constant volume $c_v = 0.1690$, are not recent values, namely, 0.2387 and 0.1701. The ratio is 1.40329. The old value which Exner uses is 1.405. In fact, the latest value is 1.402.

Succeeding chapters deal with the more general equations of dynamics and hydrodynamics, and unless one is quite conversant with spherical coordinates, there is here some hard reading.

Other chapters deal with vertical temperature distribution in the free air when at rest, which actually is seldom (if ever) the case, convection, the solar constant of radiation, the troposphere and stratosphere. The fifth chapter deals with the kinematics of moving air streams, and while the two volumes of Bjerknes are referred to, the author prefers an older treatment as being more concise and in better accord with the trend of his own memoirs; and also lending itself more readily to graphic representation. The trajectories of air flow, with points of convergence and divergence over Austro-Hungary and the Adriatic are discussed with illustrations; also the occurrence and distribution of rain on mountain summits, in connection with the deformation of stream lines.

In the last half of the book different types of cyclones and anticyclones are discussed with relation to modern theories. Thus we have the Bjerknes scheme of families of cyclones, as a series of waves or rather eddies along a polar front.

The book is a mine of information for serious readers and those who have time and care to work out the problems. In many respects it may be compared with Richardson's unique volume, "Weather Prediction by Numerical Process"; and like that book will well repay study by forecasters. For the layman it is hard of comprehension; but then let it be remembered that the vagaries of weather, that is, the complex resulting from the interplay of air streams of different pressures, temperatures, velocities and vapor content, is likewise hard to comprehend. Indeed, it is almost bewildering; and the wonder is that anticipations are fulfilled and forecasts verified as frequently as they are.

ALEXANDER MCADIE
BLUE HILL OBSERVATORY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CONDITIONS OF VALIDITY OF MACALLUM'S MICROCHEMICAL TEST FOR CALCIUM[1]

ACCORDING to A. B. Macallum (*Ergeb. d. Physiol.*, 1908, 7, 611), purpurin forms a reddish purple compound in place with calcium, and so may be used to determine the localization of calcium in plant and animal cells. The fact that purpurin is an indicator for alkalies makes it desirable to determine the reliability of this test.

To ensure the purity of solutions to be employed in this investigation the water was glass distilled and analyzed reagents used throughout. One series of experiments was made with pure solutions; and a second series with Paramoecium caudatum transferred from such solutions in which they live for days.

Neutral and slightly acid solutions of purpurin are orange, and alkaline solutions are reddish purple in color. Aqueous solutions of purpurin were added to M/24 solutions of sodium, potassium and calcium chloride and saccharose. All solutions were colored orange and in the calcium chloride solution only a heavy orange precipitate appeared.

[1] Contributions from the Department of Zoology, Smith College, No. 134.

If the solutions were made faintly acid by adding either organic or mineral acids the heavy orange precipitate persisted in the calcium chloride solution, and a fine orange precipitate appeared in the solutions of sodium and of potassium chloride. There was no change in the color of the mixtures. If the solutions were made alkaline by the addition of sodium or potassium carbonates or hydroxides all the solutions became reddish purple. The fine precipitates in the sodium and potassium chlorides disappeared, the heavy precipitate in the calcium chloride remained and became a deep reddish purple. Thus it is evident that purpurin forms a distinctive reddish purple compound with calcium only in alkaline solutions.

In view of the fact that living protoplasm is approximately neutral it was of interest to determine under what conditions Paramoecia would stain with purpurin. From cultures in which they were abundant, Paramoecia were allowed to rise into glass tubes filled with glass distilled water, and transferred to additional tubes of such water. In this way they could be freed from the culture medium and kept in distilled water for several days or could be transferred to solutions of sodium, potassium, or calcium chloride or saccharose in which they will remain alive for one or more days. Acid or alkali was added to these solutions in some experiments.

The test as devised by Macallum entails the killing of the cells. In this investigation the Paramoecia were either killed in place on cover slips by the fumes of osmic acid, then washed in 70 per cent. alcohol and stained with a saturated alcoholic solution of purpurin; or were killed by transferring them to a small amount of boiling water, then to a slide on which the water was allowed to evaporate somewhat, then fixed and stained with the purpurin solution for ten minutes. All sides were then washed in alcohol, xylol and mounted in balsam.

Paramoecia transferred from an alkaline medium containing calcium and treated with purpurin are stained locally. The pellicle, the nuclear membrane and surfaces of vacuoles become a deep reddish purple. The more concentrated the calcium and the alkali in the solutions or the longer the exposure to the calcium solution the deeper is the color. Those transferred from a medium containing sodium or potassium chlorides or saccharose are diffusely stained. The color in a neutral or acid solution is orange; in an alkaline solution is reddish purple.

Macallum's test is satisfactory if the medium from which the cells are transferred or in which they are killed is alkaline in reaction.

MYRA M. SAMPSON

SMITH COLLEGE

SPECIAL ARTICLES

THE STEWART BANK IN THE CHINA SEA

DURING a visit to the Hydrographic Office of the Navy Department at Washington last May, opportunity was given me of examining the soundings made by the sonic depth finder on the U. S. Destroyer *Stewart* in the China Sea in March, 1924. It should be here recalled that this vessel was the one on which a line of echo soundings was first carried across the Atlantic from Newport, R. I., to Gibraltar in June, 1922, and that its echo soundings were then continued through the Mediterranean and Red seas, across the Indian Ocean, and into the Pacific; profiles of depths thus determined have been published in a series of charts, numbered for the Mediterranean, H O, misc. 2496–2498, and for the Indian Ocean, H O misc. 2575–2579.

Later soundings by the *Stewart* show that, within the deep, enclosed basin of the China Sea, a bank, measuring about eight miles east–west by five across, with its summit at from 300 to 160 fathoms, rises rather rapidly from depths of 2,000 fathoms, more or less; its center is 83 miles northwest of Cape Bolinao, northwest Luzon, in 17° 16′ N, 188° 34′ E.

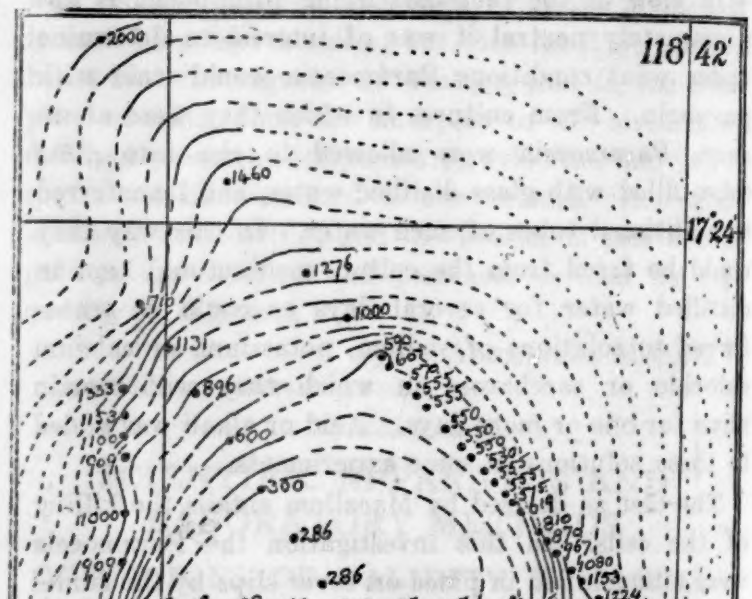
This discovery is of merit, for banks of so considerable a depth are seldom charted in the deeper oceans, perhaps less because of their objective rarity than because navigators, after finding "no bottom" at fifty or one hundred fathoms, are generally in the habit of sounding no deeper. The discovery of a deep bank is moreover of special significance in the coral-reef problem, because the lack of charted records of such banks in the coral seas has been taken as indicating their actual absence from the ocean. Yet, according to Darwin's theory of upgrowing reefs on subsiding foundations, some banks of such depths, representing strongly submerged barrier reefs and atolls, ought to be found there; furthermore, if deep banks can be produced in other ways than by the strong submergence of surface reefs, they ought to be doubly numerous; yet they are almost unknown in coral-reef regions. Evidently, if a bank of two hundred-fathom depth has already been found at, as one may say, the very outset of oceanic exploration by echo sounding, and in an oceanic region so frequently traversed as the China Sea, where other banks of smaller depth, like the Tizard and Macclesfield, appear to represent slightly drowned reefs, it is to be presumed that additional examples of deep banks representing strongly drowned reefs, as this one seems to do, will be discovered in the less-explored parts of the broad coral seas in the open Pacific, as echo sounding is more widely extended. On the other hand, if Darwin's theory be correct, such banks should

be rarer in the cooler seas; for if volcanic cones usually subside after their eruptive growth ceases, they would after their complete submergence be discovered in those seas only as cones, more or less benched by abrasion, and not as flat-topped banks, ten, twenty or thirty miles across; it would be only in the coral seas, where a subsiding cone becomes reef-crowned while it sinks slowly, that it might later, by subsiding more rapidly with its reef crown around or upon it, form a broad-topped bank of smaller or greater depth.

The manner in which the dimensions of the Stewart bank, as it will be called, were determined is gratifying: The destroyer was steaming on a northwesterly course between Manila and Hong Kong at a rate of fifteen knots an hour over depths of from 1,600 to 2,100 fathoms, and taking soundings at every three or four miles—that is, at intervals of about fifteen minutes of time—when a rapid decrease of depth from 2,140 to 300 fathoms was recorded at five-minute intervals over a distance of nine miles; then a fairly even bank was traversed with depths decreasing from 330 to 250 and increasing to 300 fathoms in the next seven miles, and finally a rapid increase of depth took place from 300 to 1,700 fathoms in the five miles following.

Now in case a rapid change of depth of this kind is detected, "General Orders" authorize the commander of a naval vessel, if a brief delay is not inconsistent with other duties, to zigzag over the bank and thus define its form and size, and especially its minimum depth; for there is small probability that that minimum, which is the most important item in regard to navigation, will be discovered on a predetermined course not chosen with respect to the bank. In view of these orders, the *Stewart*, after passing five miles beyond the bank to a depth of 1,700 fathoms, as above stated, made a sharp turn to a southward course, which was followed for seven miles, with decreasing depths to 400 fathoms on the west side of the bank, and there a square turn to the east was made, so as again to cross the bank, where depths of 258, 160 and 342 fathoms were recorded in a distance of eight miles; after which, on reaching a depth of 1,110 fathoms two miles east of the bank edge, a sharp return was made to the northwest, on a line parallel to but about four miles northeast of the original course; and there, twenty soundings being made at intervals of from one to three minutes, the side slope of the bank was followed for five miles with depths of 600, 550 and 600 fathoms, after which a rapid descent was discovered to depths of 1,000 fathoms in two miles and a slower descent to 2,100 fathoms in thirteen miles; and these great depths then continued as the vessel proceeded on its course. The entire maneuver occupied only four afternoon hours between soundings of 2,140 fathoms at two P. M., and 2,100 fathoms at six P. M. Clearly, a new era of oceanic exploration and discovery is opening, when so admirable a use of a most ingenious instrument may be made by our naval officers. It is to be hoped that, when the results thus gained are more fully published, report will be made not only upon the depths discovered, but also upon their probable error, as affected by the size of the vessel, the recording personnel, the state of the weather, the temperature of the water, and the depth, nature and slant of the ocean bottom.

On the basis of the records furnished by the Hydrographic Office, I have constructed a rough diagram



of Stewart Bank, here presented on reduced scale with submarine contours at one hundred-fathom intervals, drawn in strong lines where well defined, and in dotted lines elsewhere. The contours are presumably open to modification by more precise platting, and still more by the addition of new records. The only soundings previously recorded in this part of the China Sea are, according to H O Chart 798, 2,350 fathoms thirty-one miles to the east; 1,555, eleven miles south; 2,171, thirty-three miles west-southwest; and 2,095, forty-four miles northwest.

The interpretation and origin of the Stewart Bank are of course problematical. It may, however, be

observed that the China Sea is, like the other seas enclosed by "festoons" of islands along the border of Asia, generally regarded as occupying a basin of relatively recent down-warping; and that the occurrence of several moderately drowned or imperfectly rimmed atolls in its waters suggest that the down-warping is still in progress; furthermore, these two points taken with the small relief of the summit surface of the Stewart Bank suggest that it is more probably a drowned reef which has been built on a submerged volcano than an upgrowing volcano which has never reached the sea surface. It may also be noted that the smaller depth found at the center of the bank than at its margin suggests that it is a submerged barrier reef, the central island within which had an altitude of about 800 feet over the reef when a more rapid subsidence set in, drowning the reef and eventually submerging its central island also; and hence that it is not a submerged atoll, like the larger, reef-rimmed Tizard and Macclesfield banks, which lie some distance to the southwest in the China Sea, and which have, respectively, diameters of thirty by ten miles with a central depth of forty-eight fathoms, and of seventy by thirty-five miles and sixty fathoms.[1]

On the southeastward return from Hong Kong, the *Stewart* ran 135 miles south-southwest of Stewart Bank, and thus passed by intention close along the southwest side of Scarborough shoal, an imperfect atoll, eight miles in diameter, with a number of discontinuous reefs awash and a central lagoon; here the echo-soundings sufficed to indicate a steep submarine slope for the bank, previously undetermined.

It should be noted that no account is taken in the above records of the departure of the sounding echo from the vertical by reason of its being returned from a sloping bottom as a bank is approached and left behind; for although this refinement is made possible by the full use of the sonic depth finder, its application is seldom necessary, especially in reconnoissance work, because of the prevailing flatness of the ocean bottom. The errors thus introduced on such slopes as those Stewart Bank appears to possess are small, and of such a kind as to shift the contour lines a little outward, but by an amount hardly perceptible on the scale of the diagram here presented. Nevertheless, it would contribute to the scientific glory of the navy if the commander of one of the vessels equipped with a sonic depth finder should, on detecting a marked up-slope of the ocean floor indicative of a submerged cone or bank, thereupon so shape his course as to make a direct ascent of the steepest slope, and after passing over the highest summit of the bank, follow a direct descent down its farther side to full oceanic depth again, thus determining a diametrical profile; and then, turning 135° to one side and running 1.41 times the down-slope distance or semi-diameter from summit to full depth, turn again 135° and thus recross the summit, a fine feat of submarine mountaineering, whereby a second diametral profile would be determined at right angles to the first; thus defining the form of the bank with considerable accuracy. Such a maneuver is precisely what the sonic depth finder makes possible when its devices for determining the azimuth and dip of a returning echo from a slanting bottom are fully utilized. And let it be noted that when a bank is thus defined, the positions of the soundings on its several slopes *with relation to each other* will probably be better placed by dead reckoning from the center of the bank, aided by coincidence of close-placed summit soundings at the intersection of the crossing profiles, than would be possible if a second single line of soundings over the bank were later made independently by the same or by another vessel, the position of which would have to be determined absolutely by observation; for such a determination may depart from the similarly determined position of a first line of soundings by a mile or two; and that distance might be so large a fraction of the bank diameter as to introduce serious errors in the attempt to define its shape.

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[1] W. U. Moore and P. W. Bassett-Smith, "China Sea. . . . Results of an examination . . . of Tizard and Macclesfield banks," Hydrog. Dept., Admiralty, London, 1889. P. W. Bassett-Smith, "Dredgings obtained on the Macclesfield bank," *ibid.*, 1893; also, "Report on the corals from Tizard and Macclesfield banks, China Sea," *Ann. Mag. Nat. Hist.*, vi, 1890, 353–374, 443–458.

ELECTRONATION[1]

The terms oxidation and reduction as applied to chemical reactions have come to mean much more than the simple addition or removal of oxygen or of hydrogen to or from a substance, although many chemists and most text-books of general chemistry still attempt to explain all oxidation-reduction phenomena in terms of these two elements. For example, it is assumed that when potassium dichromate acts as an oxidizing agent it decomposes as follows:

$$K_2Cr_2O_7 = K_2O + Cr_2O_3 + 3\,O$$

The oxygen which is liberated immediately reacts with the substance to be oxidized so that its presence is never actually detectable. Similarly, nitric acid is supposed to yield oxygen when it serves as an oxidizing agent:

$$2\ HNO_3 = H_2O + 2\,NO + 3\,O$$

[1] Read before the fifty-seventh annual meeting of the Kansas Academy of Science, Manhattan, Kansas, April 11, 1925.

Some text-book writers prefer to explain the oxidizing effect of nitric acid, on metals at least, in terms of "nascent" hydrogen:

$$2\,HNO_3 + Cu = Cu(NO_3)_2 + 2\,H$$

The hydrogen which is formed reacts with some of the unchanged acid and reduces it to nitric oxide and water. Dhar has pointed out that the adherents of this explanation run into difficulty when they come to explain the oxidizing effects of nitric acid upon organic substances, where there would be no chance for the formation of "nascent" hydrogen.

There are many good arguments which have been presented against such a conception of oxidation and reduction processes. While in some few cases it may be possible that oxygen and hydrogen are formed and do actually serve as the oxidizing and reducing agents, in the majority of cases a study of the mechanism of the reaction does not warrant any such general interpretation. One of the most powerful arguments against this prevailing theory is that oxidation can take place in the absence of oxygen and that reduction can take place in the absence of hydrogen. One familiar case that the student of general chemistry will recall is that ferrous chloride can be oxidized to ferric chloride by free chlorine. Certainly there is no oxygen here and yet this is a type of reaction that all chemists agree is oxidation.

The authors have reported elsewhere the results of an investigation upon this same topic and have shown that typical oxidations can take place in liquid ammonia (a solvent containing no oxygen); for example, thallous ion may be oxidized electrolytically to thallic ion and hydrazobenzene may be oxidized to azobenzene, care being taken to choose an electrolyte that contains no oxygen. The last case is of interest in that hydrogen is removed from a compound, one of the definitions frequently used for oxidation. Similarly, it is possible to reduce substances in the absence of hydrogen. Thus in phosphoric oxychloride (a solvent containing no hydrogen) it is possible to electrolytically reduce ferric to ferrous ion and iodate ion to free iodine, the electrolyte being so chosen that it contained no hydrogen. It follows from such experimental proof that the explanation of oxidation and reduction in terms of oxygen and hydrogen is untenable, but possibly as long as the term oxidation is used it will be impossible for the student to get away from the idea that oxygen is necessarily involved.

Other terms have been suggested to cover the general phenomena of oxidation; Richards some years ago suggested the word "perduction" and somewhat later Getman suggested the word "adduction"; the term reduction was to be retained. An examination of the literature and of the text-books of general chemistry fail to show their adoption. Within the last few years Franklin has shown that reactions similar to oxidation and reduction take place in liquid ammonia. These are similar to the change that we have cited in this solvent, *i.e.*, the conversion of hydrazobenzene to azobenzene. Franklin calls changes of this type "nitridations." For example, hydrazoic acid, HN_3, is a nitric acid of the ammonia system of compounds and as such serves as a nitridizing agent.

Obviously, a multitude of words could be coined to cover analogous processes in other solvents or with various reagents; for example, "sulfidation," "carbidation," "cyanation," and so on. Still other terms as chlorination and bromination have been in use for many years. As these processes are but separate cases of a general phenomenon we have thought best to propose a new word for the general process.

In casting about for a word suitable for this general phenomenon we finally decided upon the word *electronation*. Our reasons for this are as follows:

(1) At the present time the electron theory is exceedingly popular in explaining such topics as electrolytic conduction, the structure of atoms and the mechanism of organic reactions. On account of this popularity it should not be difficult to introduce the term into the literature and the text-books.

(2) There already exist in many text-books of general chemistry a definition of oxidation and reduction in terms of electrons. This definition has the advantage of being the shortest and most concise definition of the process of any yet offered. To state it in terms of our word, *"Electronation is the addition of an electron (or electrons) to an element; de-electronation is the removal of an electron (or electrons) from an element."* The first of these processes will be seen to be equivalent to that now known as reduction and the second is equivalent to that now known as oxidation. It can be seen that the words admit readily of forming the corresponding verbs.

(3) By using these terms the explanation of the phenomenon is freed entirely from any assumption that oxygen and hydrogen are involved, an assumption which we have pointed out is very common and quite erroneous. To our minds this is one of the chief advantages of the word.

The greatest objection that can be brought against the word is that it conveys a negative idea to one accustomed to the terms oxidation and reduction. If the term is generally adopted, however, this objection would soon disappear.

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